

HARVARD COLLEGE OBSERVATORY.

THE fifty-fifth annual report of the work done at the Astronomical Observatory of Harvard College during the year ending September 30, 1900, has recently been circulated by the Director, Prof. E. C. Pickering, and is here summarised.

Observatory Instruments: East Equatorial.—The observations with this instrument were made by Prof. O. C. Wendell; during the year 24,000 photometric light-comparisons were made, principally with the achromatic prism polarising photometer. Over 15,000 of these were series of measures of twenty variables.

This instrument, with a second photometer adapted to stars nearer together, has been used for determination of the following:—

	Comparisons.		Comparisons.
o Ceti ...	1792	β Lyrae...	848
U Camelopardali.	160	Nova Aurigæ ...	96

and also in the photometric measurement of Jupiter's satellites while undergoing eclipse, eighteen eclipses having been observed; the satellites of Saturn, Japetus and Titan; the light of the planet Eros (224 settings), and in addition the systematic photometric observations of variable stars of long period have been continued.

Meridian Circle.—The ruled glass plate with which former determinations have been made for the last ten years has been replaced by spider lines, and the declination micrometer employed in conjunction for the first time. From the new observations a comparison is to be made between the accuracy obtainable by the two methods. The work of the instrument has been mainly confined to determinations of clock error and instrumental constants. The reduction of the observations made by the late Prof. Rogers from 1879–1883 is being continued.

12-inch Meridian Photometer.—With this instrument 79,024 settings were made by the Director on 140 nights. The first large work, comprising the observation of all the stars contained in the Durchmusterung, in zones 10' wide and 10° apart, is now practically completed; the total number of stars is 9233, 6195 of which are fainter than the ninth magnitude. Good progress has been made with the reductions.

Meridian Photometer.—The observations of the stars south of declination -30° , of magnitude 7.0 and brighter, were completed early in December at Arequipa. Forty-four series were taken, involving 13,244 settings. The instrument was then sent to Cambridge, mounted, and electric light substituted for gas. A catalogue of standard stars, one in each 10° square, has now been prepared, and 16 series, including 6424 settings, have been made by Prof. Bailey.

Henry Draper Memorial.—Six hundred and eighty-nine photographs have been obtained with the 11-inch Draper telescope, and 2187 with the 8-inch instrument. The examination, by Mrs. Fleming, of the spectra on these plates and on those taken with the Bruce and Bache telescopes has led to the discovery of fourteen new variable stars, ten of which contained bright hydrogen lines in their spectra, and six are gaseous nebulae. Eight variables have also been discovered in other ways. A new star in Aquila was found from examination of photographs, making the sixth object of this class detected in this manner.

In the study of the spectra of bright southern stars, it has been found that *HB* is bright in A.G.C. 8991, and variable in the two stars A.G.C. 19737 (η Centauri), and A.G.C. 20,878 (κ^2 Apodis).

Experiments are in progress for determining the photographic magnitudes of stars by the measurement of images out of focus, whereby a comparison is made of *surfaces* instead of *points*. It is found that stars can be measured in this way at the rate of five a minute, with a probable error of a tenth of a magnitude. Some 14,000 measures have been made in this way. For special purposes, charts are now being regularly taken with the 8-inch and 11-inch Draper telescopes, without following, by varying the rate of the clock and the position of the polar axis. A small telescope is rigidly attached to the base of the 11-inch telescope and directed toward two distant scales placed at right angles to each other, thereby permitting the axis to be set in any desired position rapidly and accurately. A photograph of the planet Eros was obtained in this manner on July 28, 1900, in which the image was sensibly round, although the exposure lasted 153 minutes.

Photographs of star occultations and eclipses of Jupiter's satellites have been obtained on several occasions.

Boyden Department.—As the sky was so clear at Arequipa during the latter part of 1899, it was unnecessary to remove the meridian photometer to the Desert of Atacama, Chile, as had been anticipated. Great delay has been experienced in the transmission of the plates to and from Peru, partly due to the quarantine consequent on the prevalence of fever along the west coast. The number of photographs taken with the 13-inch Boyden telescope is 201, and with the 8-inch Bache 2054.

Three hundred and fifty-eight visual observations of 48 southern variables have been made by Argelander's method. Systematic examination of all the stars south of declination -30° , between the magnitudes 6.3 and 7.0, inclusive, for the detection of new double stars, has been continued; 541 stars have thus been examined, leaving a further 450 requiring observation.

Meteorological Observations.—Observing stations have been maintained during the year at eight localities having altitudes varying from 100 to 19,200 feet; but great difficulty has been experienced at the lofty mountain stations.

These observations have now been continued for eight or nine years; taking into consideration, however, the striking uniformity of conditions which prevail in different years in this region, it is probable that additional observations would not greatly increase knowledge, and it has therefore been decided to suspend the meteorological observations of all the stations, except those at Arequipa. This seems to be a great pity, for nine years is a very short period when meteorological data are in question, and especially when the altitudes of the stations are so different.

The Bruce Photographic Telescope.—Seven hundred and sixty plates have been taken with this instrument during the year. From 319 of these 198 new faint nebulae have already been detected. On these plates thus examined have also been found 92 asteroid trails and 2 meteor trails. In the spring of 1900 successful photographs of Eros were obtained by a special method when the object was too faint for ordinary procedures. The photographic plate was moved during exposure at the rate calculated for the motion of Eros relative to the diurnal motion. Three good plates were thus obtained on April 28, 30, 31, 1900.

A long series of photographs of Saturn was taken, to determine, if possible, the orbit of the satellite Phœbe. From an examination in Arequipa the existence of this object has not been confirmed; a careful examination will again be made on the arrival of the plates at Cambridge.

Blue Hill Observatory.—The chief work here has been the continuation of the exploration of the upper atmosphere by means of self-recording instruments carried by kites. The greatest height attained was 15,800 feet.

Miscellaneous.—(1) The scheme of distribution of important astronomical news is now greatly appreciated. Twenty bulletins have been issued during the year. These are sent gratuitously to all who desire them, and telegrams will be sent on payment of official fees.

(2) The long focus telescope obtained last year, with aperture of 12 inches and focal length of 136 inches, was lent to Prof. Langley, of the Smithsonian Institution, for photographing the corona during the eclipse of the sun in May 1900, the results being highly satisfactory.

(3) By the aid of an appropriation from the Rumford Fund of the American Academy, an important investigation has been started for the determination of standards for faint stellar magnitudes. For this work telescopes of 40, 36, 26, 15 and 12 inches aperture will be used, by the generous co-operation of the Yerkes, Lick and McCormick observatories with that of Harvard.

(4) A considerable number of photographs of the planet Eros have been taken, but as it is considered that the present opposition will not afford improved values of the solar parallax, it is doubtful if they will all be measured, unless the number obtained elsewhere be insufficient. Considerable care will, however, be taken in determining the variations of the light of the planet, both photographically and visually.

Establishment.—Prof. Pickering marks the completion of the work of the Observatory for the nineteenth century by giving a detailed account of the needs of the institution and the conditions of those portions of its work which are at present unfinished. The annual income is nearly 10,000/., but this is required for current expenses. The estimated value of the buildings and instruments at Cambridge is about 15,000/., and at Arequipa about 12,000/.

The main building at Cambridge is of wood, more than fifty years old, and the whole, including the invaluable astronomical library, is in constant danger of destruction by fire. The estimated cost of new modern buildings is about 20,000*l.* A large telescope for work at present entirely neglected in the southern hemisphere could also be obtained for a further 20,000*l.*

A long list of the principal unpublished investigations is given, most of which are ready for completion if means be forthcoming. These will occupy about twenty-eight volumes of the *Annals*, *i.e.* almost two-thirds as many as have already been published during the half-century of the existence of the Observatory.

SCIENCE IN TECHNICAL AND PREPARATORY SCHOOLS.¹

EDUCATION is probably more discussed at the present time than ever it was before. It has become a subject for the newspapers, and to some extent for the political platform. It would seem there is now really a hope that the ordinary man of affairs will soon appreciate its importance. The advocates of education in science and technology have for years appreciated the reality and understood the reason of successful foreign competition, and now the lesson is being impressively driven home to every manufacturer by the tale of diminishing exports. Facts such as these give the recent report, made for the Department of Special Inquiries of the Board of Education by Mr. James Baker, on technical and commercial education in East Prussia, Poland, Galicia, Silesia and Bohemia, a very high value. Written as it is from the point of view of a skilled observer generally interested in the development of British industry and commerce, the report will receive more careful attention from the practical men engaged in manufacture than would the opinion of a mere student of pedagogics.

With the exception, perhaps, of the part of Russia he visited, though even there some progress is being made, Mr. Baker tells of the rapid advances he found have taken place everywhere in the development of technical and commercial education. And, what is of particular importance to us in this country, he demonstrates that the efficiency of any nation's supply of technical instruction in its various grades depends directly upon the satisfactoriness or otherwise of the national supply of primary and secondary education. It is that student alone who has received a thorough and suitable grounding in preliminary subjects who benefits by the specialised instruction of the trade school and technical college.

But this cause by itself is not sufficient to explain the high standard of foreign systems of technical education. In Prussian Poland and in parts of Austria the want of continuity between the work of the day schools and the higher technical studies of the trade schools has been abolished by legislation. In this country attendance at school during the years of apprenticeship is optional with the result that even if the young workmen ever reach the classes specially designed to instruct in particular industries they have forgotten completely, by that time, their elementary knowledge; in the countries named, however, attendance at evening continuation or other schools is as compulsory as that at the ordinary day school. For instance, in describing the provisions for technical instruction at Posen, a town of 100,000 inhabitants in Prussian Poland, Mr. Baker writes of the Fortbildungsschules (continuation school, and the Gewerbschule or trade school: "This is for learners in all handicrafts. There is no payment, but the apprentices in all trades are compelled to attend this school under penalty of fine or even imprisonment. Lads commence here at fourteen and continue until eighteen, attending two afternoons a week and in the evenings. The employers are compelled to give their apprentices two afternoons a week, unless they are engaged upon work outside the town, when the lads are excused from attendance." Similarly, in connection with Trautenau, the Bohemian flax centre, with 16,000 inhabitants, we find: "Here all the apprentices must attend the trade continuation classes, which are held from six to eight in the evening and from

eight to twelve a.m. on the Sunday. . . . In the Commercial Continuation School the same applies to business apprentices." And similar examples could be multiplied.

But it is impossible to manufacture, by any system of compulsion, enthusiastic students anxious to master everything known about the science of their trade and filled with a desire to improve upon the methods generally adopted. Continental authorities recognise this. It may be possible to raise the average ability of the workmen by enforced attendance at evening schools, but to discover the specially endowed craftsman who will repay all the trouble taken to place opportunities in his way, other plans are adopted. Here is one, expressed in Mr. Baker's words: "There is one great leverage the German schoolmaster possesses wherewith to lift his pupils into good work that an English teacher does not possess, and that is the fact, if a certain grade of work is passed, the student is freed from one or two years of military life, becomes a 'volunteer,' and only serves one year." But it is only in exceptional cases that this rule applies in Austrian towns, at all events in the lesser towns. Another means of attaining the same object is very common. In those schools which have not the right to exempt their pupils from one year of military service, an *Ausweis*, or leaving document, is employed, and on this is set forth the progress made, the behaviour and the diligence of the pupil, with a record of the attendance and a list of the subjects studied by the young man. This record has to be produced when the youth is called up for his time with the colours, and if the report is bad he may have to serve three years instead of two.

This subject of compulsory military service brings into high relief one great advantage the British workman has over his Continental contemporary in point of time. Mr. Baker writes eloquently in this connection: "In going through these technical schools I saw young men working at the most delicate handicrafts; they had just arrived at excellency; their skilled hands, guided by a highly cultured brain, were turning out work most delicately artistic; but they must lay down their tools and take up sword and rifle for two years, or three if in the cavalry or artillery; their hands must forego the exercise of their cunning, if they do not lose it altogether; . . . Herein is the Englishman's opportunity when he obtains the same advantages of education as the Austrian or German; he can at once leap ahead of his Continental competitor, for he gains these two years given up by the Continental to military service."

But perhaps the most remarkable characteristic of Austrian technical education is the extent to which decentralisation has been carried throughout the country. While making due provision for advanced work in a few large centres, the object of the authorities seems to be to bring suitable instruction in the technology of the particular industry of a district to the very doors of the workers. A notable instance of this, and it is typical, is the case of Turnau, or Turnov, the jewellers' town. It is a little place of 6500 inhabitants, whose chief industry is goldsmiths' work and the polishing and setting of jewels. Here has been established a Royal Imperial trade school for jewel cutting, polishing, engraving and setting in gold, but in addition to this technical institute there are four Volksschulen (primary schools), a Bürger school, and a continuation school in winter for handicraftsmen. The students of the Royal Imperial trade school come direct from the Volksschulen, beginning this special work at fourteen and remaining for four years. The tuition is free, but the lads receive no pay. The total number of pupils in the school is seventy-eight, and they are all being converted into cultured artisans. When they pass out of the school they are given a leaving certificate, which confers the full status of a workman and ensures treatment as an educated man for the holder.

The question naturally presents itself, What manner of men are in charge of institutions the object of which is to produce accomplished artisans who are also at the same time educated in a higher and more general sense? On this subject, too, the report under consideration supplies abundant information. In the description of the technical college at Prague a short life-sketch of Director Edward Cerny is given. He bears the title, by the way, of Royal and Imperial Councillor—a proof of the esteem in which men of science and educational leaders are held in Austria, where, as in Germany, such authorities are commonly nominated Privy Councillors, and receive titles and decorations. It is impossible in a short article to refer to all Director Cerny's qualifications; it must suffice to say that his case is quite general and that the common rule is to appoint

¹ Report on Technical and Commercial Education in East Prussia, Poland, Galicia, Silesia and Bohemia. By James Baker, 122 pp.
Board of Education Special Reports on Educational Subjects. Volume vi. Preparatory Schools for Boys: their Place in English Secondary Education. 531 pp.